PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

EX PARTE CHEN

Application for Patent

Filed: September 28, 2000

Serial No. 09/676,269

FOR:

CHAMBER CONFIGURATION FOR CONFINING A PLASMA

APPEAL BRIEF

CERTIFICATE OF MAILING
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Signed: ______________________
Agnes F. Spence

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(1) REAL PARTY IN INTEREST

LAM RESEARCH CORPORATION, which is the assignee of the present application.

(2) RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

(3) STATUS OF CLAIMS

Claims 1-10, 12, 13, 15-24 and 26-31 are pending in the application. Claims 1-21 were submitted with the application as filed. During prosecution, claims 22-31 were added, claims 11, 14 and 25 were cancelled, and claims 1, 8, 10, 12, 15-21 and 23 were amended.

<u>All rejections of claims 1-10, 12, 13, 15-24 and 26-31 are appealed.</u>

(4) STATUS OF AMENDMENTS

No amendments have been made since the final rejection.

(5) SUMMARY OF INVENTION

In capacitive plasma reactors, a capacitive discharge is formed between a pair of parallel electrodes when RF power is applied to one or both of the electrodes. Although the plasma predominantly stays in the process area between the pair of electrodes, portions of the plasma may fill the entire chamber. A plasma typically goes where it can be sustained, which is almost anywhere in the chamber. By way of example, the plasma may fill the areas outside the process region such as the bellows of the pumping arrangement. If the plasma reaches these areas, etch, deposition and/or corrosion of the areas may ensue, which may lead to particle contamination inside the process chamber, and/or which may reduce the lifetime of the chamber or chamber

parts. Furthermore, a non-confined plasma may form a non uniform plasma, which may lead to variations in process performance (see for example page 1, lines 27-33).

It has been discovered that unwanted discharges or plasmas may be encountered when large charged particle fluxes and/or large electric fields are present in regions outside of the process region of the process chamber. As the term is employed herein, the process region refers to the region of the process chamber used for processing a substrate, for example, the area directly above the substrate. With regards to charged particles, charged particles leaving the process region may collide with the wall of the process chamber, and as a result generate secondary electrons that can ignite and/or sustain a plasma. With regards to the electric field, an electric field can accelerate the electrons causing them to collide with the gas molecules of the process gas, which as a result can ionize and initiate a plasma. In addition, charged particles tend to follow the electric field lines and thus stray electric field lines may guide more charged particles into regions outside of the process region of the process chamber. For example, electric fields can accelerate charged particles in a direction towards the walls of the process chamber. This acceleration and subsequent collision between the charged particles and the chamber walls may generate secondary electrons, which may ignite and/or sustain a plasma (see for example page 6, lines 12-27).

As shown in Fig. 1 (which is reproduced below), the present invention provides a plasma confining system 50 for confining a plasma in a process region 26 of a process chamber 12. The system 50 includes at least a confining assembly 51. The confining assembly 51 is configured for capturing (neutralizing) a portion of the charged particles that stray out of the process region 26 and for attenuating the electric field lines that stray out of the process region 26. The confining assembly 51 comprises a first confining element 54, which is positioned towards a side of the process region 26, and which includes an exposed conductive surface 88 that is electrically grounded. The assembly 51 also includes a second confining element 53, which is positioned towards the side of the process region 26 and spaced apart from the first confining element 54. Unlike the cited art, the second confining element 53 includes <u>an exposed insulating surface 82 covering an un-exposed conductive portion</u>

80 that is electrically grounded. (see for example pages 12-3, lines 21-5 and pages 14-18, lines 32-21).

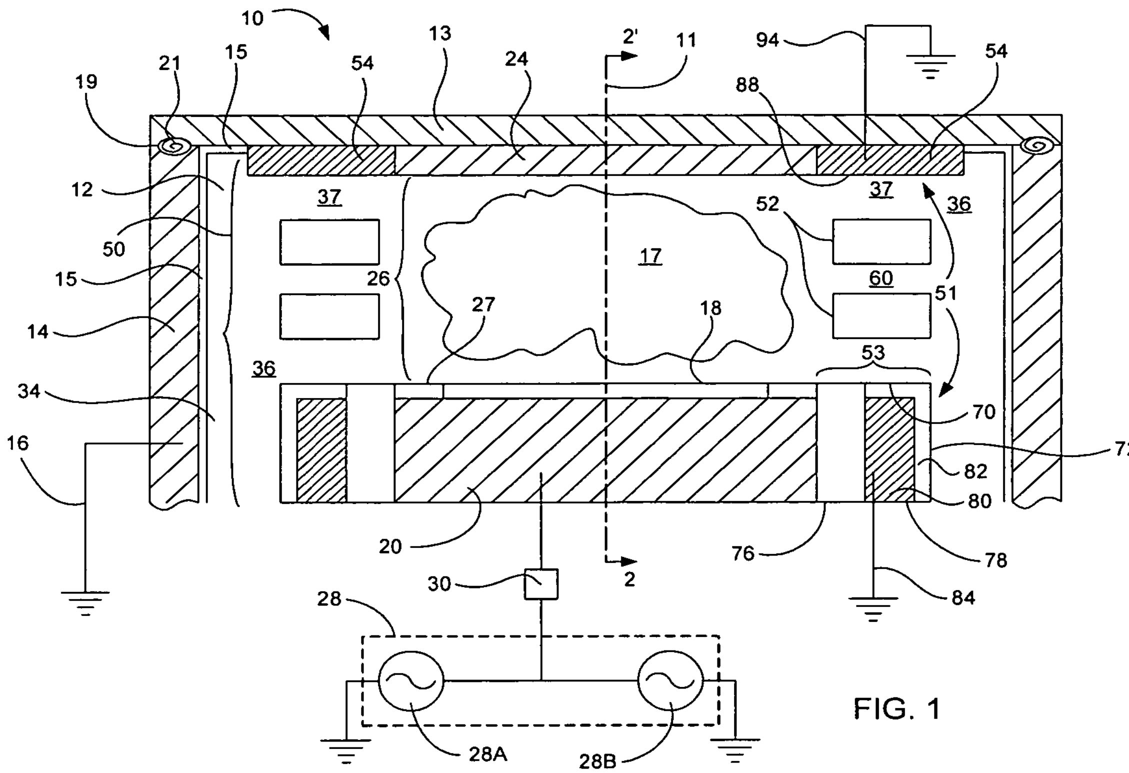


FIG. 1

It is generally believed that the above assembly 51 achieves plasma confinement by capturing charged particles streaming out of the process region 26 of the process chamber and shielding portions of the electric field straying outside of the process region 26 of the process chamber 12. For instance, the assembly 51 is configured to direct charge particles to the conductive surface 88 of the first confining element 54 and sink particles therethrough to ground so as to reduce the density of charged particles in regions outside of the process region 26. The assembly 51 is also configured to neutralize some of the charged particles on the pressure control ring 52 so as to reduce the density of charged particles in regions outside of the process region 26. Moreover, the assembly 51 is configured to redirect stray electric fields through the confining elements 53 and 54 and to ground so as to reduce electric fields in regions outside of the process region 26. For example, the direction of electric fields can be altered so that the electric fields no longer have a line of sight that

extends to the outer regions of the process chamber 12 or the chamber walls 15. (See for example pages 7-8, lines 21-2 and Fig. 2 of the present invention, which is reproduced below).

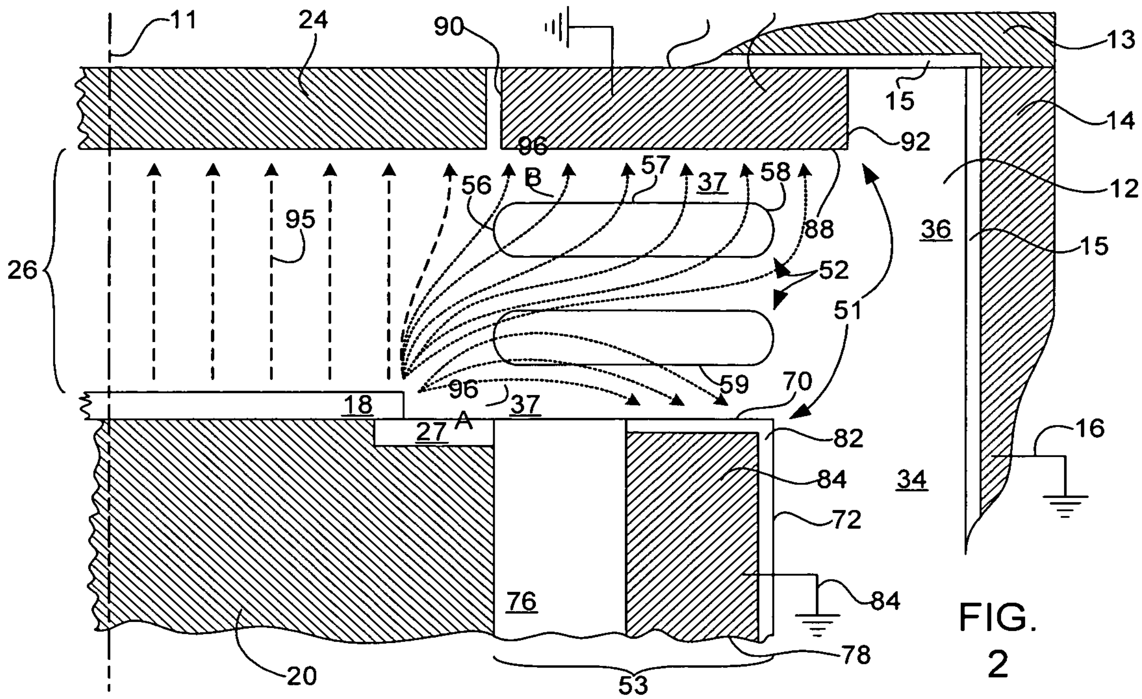


FIG. 2

In summary, it is generally believed that the arrangement of the exposed conductive surface and an insulated conductive core work together to better confine a plasma and prevent unwanted plasma discharges (see for example page 17, lines 5-15). If configured differently, the confining assembly would not function properly (see for example Fig. 7 and pages 21-22 of the present application).

(6) ISSUES

The issues, which Appellant believes to be most pertinent to the present appeal, include:

A) Whether the Examiner made a proper prima facie case of obviousness.

B) Whether any of the cited art renders any of the claims unpatentable.

(7) GROUPING OF THE CLAIMS

With regards to patentablity, claims 1, 2, 3, and 13 will be argued as a group, claims 23, 25, 18 and 22 will be argued as another group and claims 4-10, 12, 16, 17, 19-21, 24, 26-31 will each be argued separately and thus they do not stand or fall together.

(8) ARGUMENTS

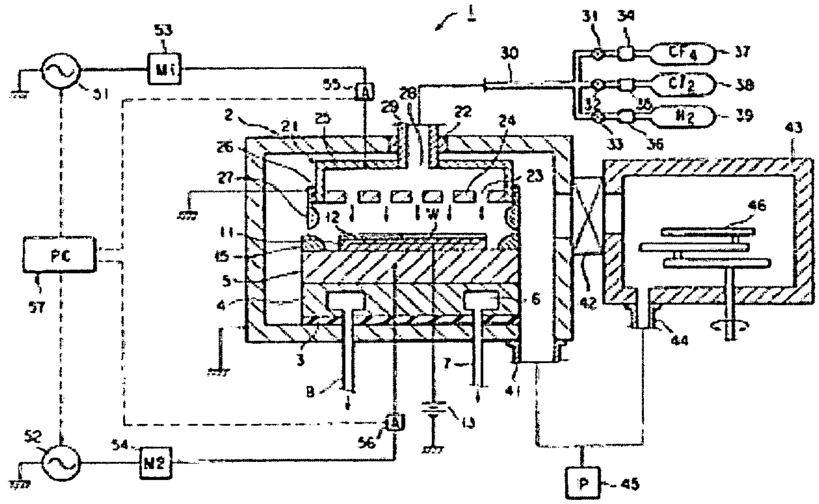
After summarizing the prior art, the issues will first be discussed with regards to the Examiner failing to make a prima facie case of obviousness and then in terms of patentability.

Summary

In the cited reference *Imafuku* (U.S. Pat. No.: 6,074,518), a means for enclosing a plasma in a plasma generation region is provided. The means generally includes a third electrode and possibly a fourth electrode, both of which are NOT one of the parallel electrodes used to generate the plasma. These electrodes are electrically grounded rather than being coupled to an RF source as the parallel electrodes. The grounded electrodes prevent plasma diffusion by attracting ions thereto. That is, ions which tend to diffuse outside the plasma generation region positively move to the ground electrodes thereby preventing plasma diffusion.

Initially, as shown in Fig. 1 (which is reproduced below), *Imafuku* describes a single ground electrode 27 in combination with a focus ring 15. The ground electrode 27, which surrounds the space region between the upper electrode 21 and susceptor 5 from its side portion, is electrically grounded. The ground electrode 27 attracts ions which tend to scatter horizontally outward from the space region thereby preventing them from being scattered to the outside of the space region, i.e., the inner wall of the chamber (See Col. 8, lines 36-44). The focus ring 15, which is arranged at the peripheral edge portion of the upper end of the susceptor 5 so as to surround the wafer W, consists of an insulating material, which does not attract reactive ions and lets reactive ions produced by a plasma be effectively incident on only the wafer W at the inner side of the susceptor 5 (see Col. 6, lines 62-65).

6,074,518



F I G. 1

Imafuku later teaches a pair grounded electrodes 27 and 66 as shown in Fig. 5 (which is also reproduced below). Ground electrode is 27 is arranged around the upper electrode 21, and the other ground electrode 66 is arranged around the vicinity of the upper end portion of the susceptor 5. It appears that ground electrode 66 replaces the focus ring 15 of the first embodiment. With this arrangement, charged particles, which tend to scatter from the vicinity of the upper electrode 21 are attracted to the ground electrode 66 and charged particles which tend to scatter from the vicinity of the susceptor are attracted to the ground electrode 27. As a result, the plasma generated between the upper electrode 21 and the susceptor rarely diffuses to the inner wall of the chamber 2 (see Cols. 9 and 10, lines 60-8).

6,074,518

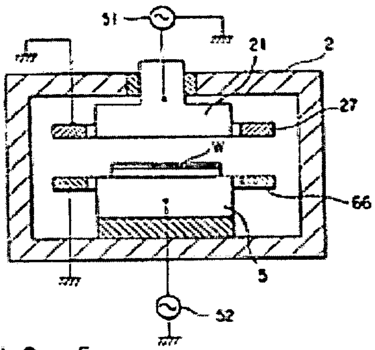


FIG. 5

Imafuku reiterates both of these embodiments in Col. 11, lines 58-67 and Col. 12, lines 5-8, which states, "An apparatus shown in Fig. 11 is provided with a ring like gas diffusion discharge guide 47 at the peripheral portion of the upper surface of the susceptor 5 in place of the focus ring. This guide can consist of an insulating member or a conductive member. When it consists of a conductive member, it may be grounded or need not be grounded." Fig. 11 is reproduced below.

6,074,518

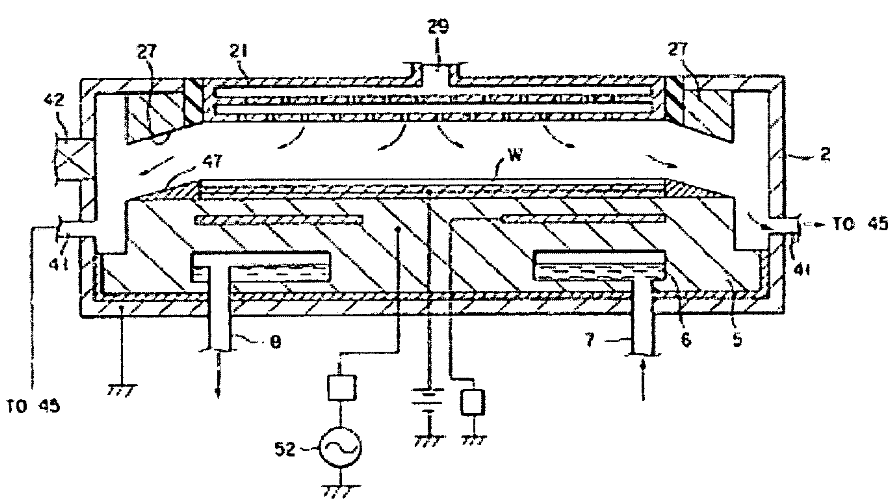


FIG. 11

Similarly to *Imafuku*, the present invention provides a plasma confining system 50 for confining a plasma in a process region 26 of a process chamber 12 as shown in Fig. 1 of the present invention (see summary). The system 50 includes at

least a confining assembly 51 comprising a first confining element 54, which is positioned towards a side of the process region 26, and which includes an exposed conductive surface 88 that is electrically grounded and a second confining element 53, which is positioned towards the side of the process region 26 and spaced apart from the first confining element 54.

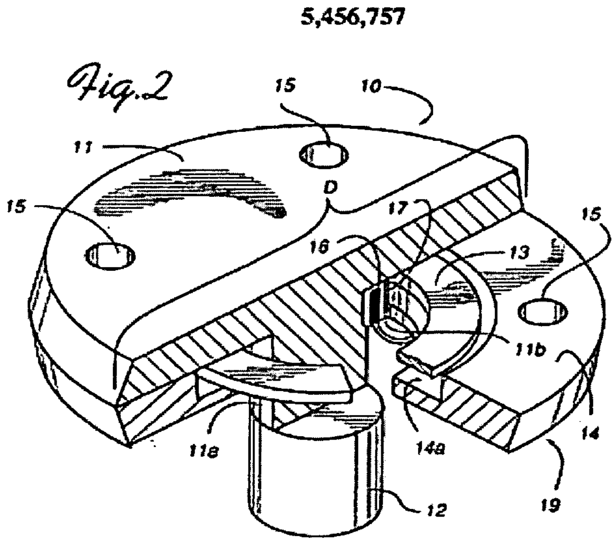
Unlike *Imafuku*, however, the second confining element 53 includes <u>an exposed insulating surface 82 covering an un-exposed conductive portion 80 that is electrically grounded</u> (see Fig. 1 of the present invention). This is different than *Imafuku* in that *Imafuku* only teaches a pair of exposed ground electrodes 27 and 66, or a single exposed ground electrode 27 in combination with a focus ring 15, i.e., insulator. *Imafuku* simply does not teach an insulated ground electrode. Also unlike *Imafuku*, the plasma confining system may additionally include an insulated pressure control ring 52, which is also positioned towards the side of the process region 26, and between the first and second confining elements 53 and 54. The pressure control ring 52 is configured for physically confining the plasma 17 and for neutralizing a portion of the charged particles that stray out of the process region 26. *Imafuku* is silent to placing anything between the ground electrodes 27 and 66 or between the ground electrode 27 and the focus ring 15.

In the office actions, the Examiner acknowledged the differences between the present invention and *Imafuku*. In order to maintain a rejection therefore, the Examiner sought secondary references to cure the deficiencies thereof. The primary secondary reference is *Aruga* (U.S. Pat. No.: 5,456,757). Unlike *Imafuku* and the present invention, however, *Aruga* makes no mention of plasma confinement or ground electrodes. *Aruga*'s main objective is to enclose one of the RF electrodes of the capacitive plasma reactor with a ceramic material. *Aruga* states,

> "In the preferred embodiment, the susceptor assembly is used as a high frequency electrode by attaching an electrode plate to the bottom surface of the susceptor plate. The electrode plate is covered by an electrode cover made of a ceramic material and demountably attached to the susceptor plate such that any adverse effect of the fluorine plasma is avoided (Col. 2, lines 55-61)."

As shown in Fig. 2 (which is reproduced below) and described in Col. 3 lines 17-21 of *Aruga*, the susceptor assembly 10 consists of a susceptor plate 11, a metallic

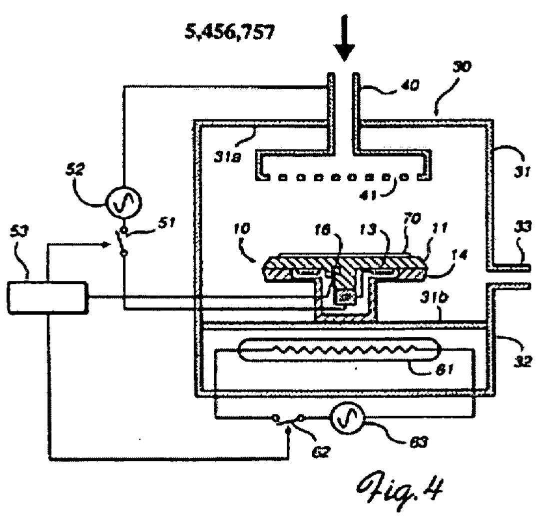
electrode plate 13 affixed to the back of the susceptor plate 11. An electrode cover 19 is mounted to the back surface of susceptor plate 11 to cover the metallic electrode plate 13.



Aruga further states in Reference to Fig. 4 (which is also reproduced below),

"the reaction gas inlet 40 also serves as the RF electrode and is in a paired relationship with the metallic electrode plate 13 in the susceptor assembly 10. The RF electrode 40 and metallic electrode plate 13 are connected to a high frequency power source 52 through a control switch (Col. 4, lines 21-26)."

"Along with the introduction of the fluorine containing gas, control switch 51 is turned on and a voltage is applied to the reaction gas inlet 40 and metallic electrode plate 13 positioned in the susceptor assembly 10. This ignites a fluorine containing plasma inside the reaction chamber 30 (Col. 5, lines 7-13)."



A. ***Defective Prima Facie Obviousness Rejections***

With regards to *Imafuku* and *Aruga*, the Examiner stated that it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of *Imafuku* so as to cover the second confining element with an insulator as suggested by *Aruga* et al. because in such a way the conductive portion of the second confining element would not be attacked by the plasma. With regards to *Hasegawa* (U.S. Pat. No.: 5,271,788), the Examiner stated, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Imafuku et al modified by Aruga so as to form the second confining element so as to surround the lower electrode because in such a way the electrode would be protected from the plasma and therefore, the apparatus of Imafuku et al modified by Aruga et al. would be optimized.

It is the Applicant's belief however that the 103 rejections are improper and should be withdrawn. In particular, the Examiner has not met the burden of establishing a prima facie case of obviousness.

1. Prior art teaches away

It is believed that *Imafuku* and *Hasegawa* teach away from the present invention. The Supreme Court held in U.S. v. Adams, 383 U.S. 39, 148 USPQ 479 (1966), that one important indicium of nonobviousness is "teaching away" from the claimed invention by the prior art or by experts in the art at the time the invention was made. Teaching away is the antithesis of the art suggesting that the person of ordinary skill go in the claimed direction.

Imafuku

Imafuku teaches a pair of ground electrodes (see Summary above). The present invention, however, explicitedly teaches against such an approach. The present invention teaches that this approach may disadvantageously cause electrons and negative ions to become trapped in a potential well defined by the sheaths formed

on opposing conductive surfaces that are grounded, i.e., grounded electrodes 27 and 66. As a result, a glowing discharge can be induced through the collisions of other ions and neutrals with the trapped negative species. In fact, the present invention states, "the combination of a conductive top surface and conductive bottom surface (as disclosed in Imafuku) can adversely effect plasma confinement (page 21)." In the present invention, it is the combination of a conductive surface and an insulated conductive core, both of which are grounded that greatly improves plasma confinement and the prevention of unwanted plasma discharges. To emphasize the above, see Fig. 7, and page 21 (line 23) to page 22 (line 7) of the present invention, which are both reproduced below:

> "As discussed above, the combination of a conductive top surface (e.g., outer side ring) and an insulating bottom surface (e.g., upper ring) or the combination of a conductive bottom surface (e.g., upper ring) and an insulating top surface (e.g., outer side ring) can greatly improve plasma confinement. Unfortunately, however, the combination of a conductive top surface (e.g., outer side ring) and a conductive bottom surface (e.g., upper ring) can adversely effect plasma confinement. To facilitate discussion, Fig. 7 shows a confinement assembly 300 including a lower ring 208 having a conductive top surface 210 and an upper ring 54 having a conductive bottom surface 88. As shown, there is nearly line-of-sight path between the outer edge of the upper ring 54 and the outer edge of the lower ring 208. The electrons or negative ions 302 may become trapped in the potential well defined by the sheaths formed on the conductive bottom surface 88 of the upper ring 54 and the conductive top surface 210 of the lower ring 208. Similar to the hollow cathode effect, these trapped negative species 302 oscillate back and forth in the potential well. As a result, a glowing discharge can be induced through the collisions of other ions and neutrals (not shown) with the trapped negative species 302. Accordingly, either a combination of a dielectric upper ring and an outer side ring with a conductive surface or a combination of a conductive upper ring and an outer side ring with a dielectric top surface is implemented to improve plasma confinement."

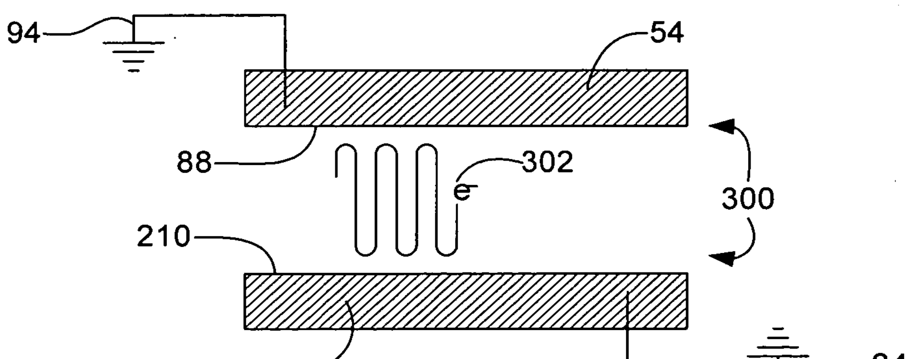


FIG. 7

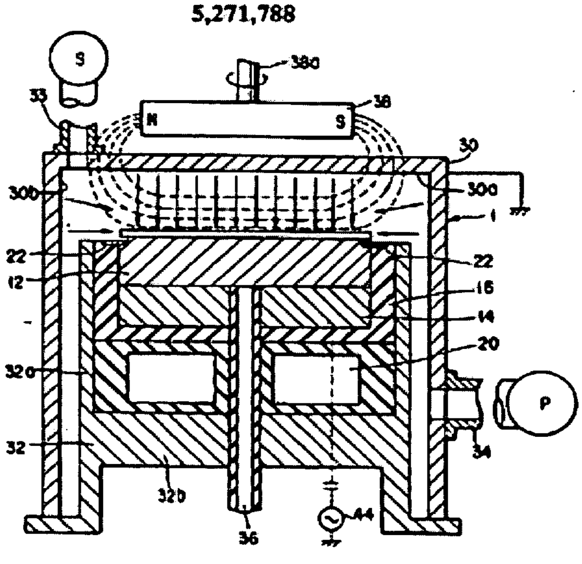
Based on the foregoing, it is submitted that a prima facie case of obviousness has not been properly made. Accordingly, it is respectfully requested that the Board reverse the Examiner's rejections and remand the application to the Examiner with directions to allow all of the claims.

Hasegawa

The Examiner further modified the apparatus of *Imafuku*, which is already modified by *Aruga*, with *Hasegawa*.

It is the Applicant's belief however that the combination is improper since *Hasegawa* teaches away form the claimed invention. As shown in Fig. 3 (which is reproduced below), *Hasegawa* discloses a conductive ring 22 that attracts electrons floating in the plasma generation region. The conductive ring 22 <u>electrically contacts</u> the susceptor 12 and thus it is electrically connected to the RF power source 44 rather than being grounded as required by the claims. One may even say that the conductive ring is an extension of the susceptor. In contrast, the present invention explicitedly teaches insulating the un exposed conductive core from the bottom electrode. The present invention reads, "...the inner side ring 76 is formed from an electrically insulating material so as to isolate the outer side ring 78 (which is configured with the conductive core 80) from the RF driven bottom electrode 20 and to prevent any electrical break down or arcing therebetween (page 15, lines 21-23)."

5,271,788



F I G. 3

Based on the foregoing, it is submitted that a prima facie case of obviousness has not been properly made. Accordingly, it is respectfully requested that the Board reverse the Examiner's rejections and remand the application to the Examiner with directions to allow claims 8, 10, 16-24 and 26.

2. The prior art does not teach the discovery or source of the problem.

Not only is it believed that the rejections are improper for teaching away, it is also believed that the rejections are improper because the prior art does not teach the discovery or source of the problem.

The present invention insulates the conductive core for a substantially different purpose than the combination of *Imafuku* and *Aruga*. *Imafuku* is silent to insulating altogether, and *Aruga* insulates for plasma protection. Although reducing plasma attacks is a benefit of having insulation, it is not the reason for doing so in the present invention. In the present invention, the insulating surface is provided to capacitively terminate the ambient RF to the conductive core through the insulating layer (see for example page 15, lines 29-31). Accordingly, the rejections are improper and should be withdrawn.

Based on the foregoing, it is submitted that a prima facie case of obviousness has not been properly made. Accordingly, it is respectfully requested that the Board reverse the Examiner's rejections and remand the application to the Examiner with directions to allow all of the claims.

3. There must be a basis in the art for combining or modifying references.

It is believed that the Examiner improperly combined *Imafuku* and *Aruga*. As stated in previous responses, the mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination.

The Examiner asserted that *Aruga* provides ample motivation to cover a conductor with an insulator in a plasma environment and that *Aruga* is being used for the broad teaching of covering a conductor with an insulator for protection in a plasma environment, no any other specific apparatus limitations such as showing a confining element.

The Applicant disagrees with the Examiners assertion. *Aruga* simply provides no motivation for protecting something other than the RF electrodes. There is no hint or suggestion in either reference that would direct someone skilled in the art to apply those principals to something other than the RF electrodes. Again *Aruga* does not teach or suggest confining a plasma and therefore does not teach any confining elements such as the ground electrodes described in *Imafuku* or the confining assembly described in the present invention. The metallic electrode plate 13 is connected to a high frequency power source and thus is not a confining element, but rather an electrode for igniting a plasma. Not only that, but one skilled in the art would not be inclined to take a feature from an RF electrode for igniting a plasma and add it to a ground electrode for diffusing a plasma since igniting and diffusing are opposite functions. As should be appreciated, igniting is associated with plasma growth while diffusing is associated with preventing plasma growth.

As mentioned, the purpose of the ground electrodes in *Imafuku* is to diffuse the plasma. If they indeed perform this function then they would not need plasma protection. That is, since the ground electrodes are trying to prevent plasma diffusion in regions proximate thereto, one skilled in the art would not be motivated to protect them from a plasma. There would be no plasma to attack the ground electrode. Even if a plasma existed near the ground electrodes, it would be minimal due to the fact that the plasma is diffused by the ground electrodes. Not only that, but protecting the ground electrode would not be as important as protecting the metallic electrode because of the needs surrounding these devices.

Furthermore, since there is no suggestion to be selective with plasma protection, one skilled in the art would not place an insulator on just one of the ground electrodes as indicated by the Examiner. If plasma protection were needed, one skilled in the art would cover both of the ground electrodes, not just one. And this

does not read on the claimed invention. Neither reference teaches selectively placing an insulator on only one conductor.

Based on the foregoing, it is submitted that a prima facie case of obviousness has not been properly made. Accordingly, it is respectfully requested that the Board reverse the Examiner's rejections and remand the application to the Examiner with directions to allow all of the claims.

4. References are not properly combinable or modifiable if their intended function is destroyed.

Even if there is a basis for combining the references, the references are not properly combinable if their intended function is destroyed. One skilled in the art would simply not enclose the ground electrode of *Imafuku* with the ceramic of *Aruga* because this would lead to an apparatus that would not work as intended. The ground electrode of *Imafuku* works because it is exposed. The ground electrode is configured to attract ions. If one were to cover the ground electrode with a ceramic, the ground electrode would no longer perform in this manner, i.e., it would not attract ions as described in *Imafuku*. As a result, the ions would diffuse outside the plasma generation region thereby creating outward diffusion of the plasma. In fact, *Imafuku* indirectly teaches away from insulating the ground electrodes in this manner when he states, "the focus ring consists of an insulating material which does not attract ions." The object of the ground electrode is too attract ions. Insulating it would simply go against this objective, i.e., prevent attraction.

Based on the foregoing, it is submitted that a prima facie case of obviousness has not been properly made. Accordingly, it is respectfully requested that the Board reverse the Examiner's rejections and remand the application to the Examiner with directions to allow all of the claims.

5. Conclusion

The prior art simply does not provide any impetus to do what the present invention has done and thus the rejections should be withdrawn, i.e., a prima facie case of obviousness does not exist. Although the Federal Circuit has repeatedly warned against it, it appears that the Examiner used the Applicant's disclosure as a blueprint to reconstruct the claimed invention out of isolated teachings in the prior art. See for example, Grain Processing Corp. v American Maize-Products, 840 F.2d 902, 907, 5 USPQ2d 1788, 1792 (Fed. Cir. 1988).

B. Patentability

<u>Independent Claim 1 (and claims 2, 3, 13)</u>

While *Aruga* may disclose a plasma enhanced chemical vapor deposition device, *Aruga* simply does not overcome the deficiencies of *Imafuku*. In contrast to both references, claim 1 (and its dependents) specifically requires, "...an exposed insulating surface, which is configured to at least partially cover a non-exposed conductive core that is electrically grounded." Neither reference teaches or suggests such a feature. Again, *Imafuku* only teaches a ground electrode in combination with an insulator or another ground electrode. *Imafuku* does not teach insulating one of the ground electrodes as required by the claims. Furthermore, *Aruga* is completely silent to confining elements altogether. The most that can be said is that *Aruga* teaches covering an RF electrode with an insulator. RF electrodes, however, are not plasma grounded confining elements, but rather plasma inducing elements (RF electrodes) that are coupled to an RF voltage source. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Although the rejections to the dependent claims 4-7, 9 and 27-29 should be withdrawn for at least the same reasons as given above, it should be noted that they offer additional language that is unsupported by the art.

Claim 4

Also in contrast to the cited references, claim 4 specifically requires, "...wherein the plasma forming components are charged particles or electric fields." Both references completely fail to teach or suggest reducing the effects of electric fields. *Imafuku* only discloses attracting ions and *Aruga* is silent to confining elements altogether. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 5

Also in contrast to the cited references, claim 5 specifically requires, "...wherein the first confining element and the second confining element are arranged to direct charged particles to the exposed conductive surface and sink charged particles therethrough to ground so as to reduce the density of charged particles in regions outside of the process region." None of the references teach such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 6

Also in contrast to the cited references, claim 6 specifically requires, "...wherein the first confining element and the second confining element are arranged to attract electric fields to the grounded conductive surface and the grounded conductive portion, respectively, so as to reduce the electrical field strength in regions outside of the process region." None of the references teach such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 7

Also in contrast to the cited references, claim 7 specifically requires, "...wherein the first confining element is disposed in an upper portion of the process chamber, and wherein the second confining element is disposed in a lower portion of the process chamber." None of the references teach such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 9

Also in contrast to the cited references, claim 9 specifically requires, "...wherein the first confining element is disposed in a lower portion of the process chamber, and wherein the second confining element is disposed in an upper portion of the process chamber." None of the references teach such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 27

Also in contrast to the cited references, claim 27 specifically requires, "...wherein the exposed conductive surface faces the exposed insulating surface such that the exposed insulating surface is disposed between the exposed conductive surface and the non exposed conductive core." None of the references teach such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 28

Also in contrast to the cited references, claims 28 specifically requires, "...wherein the insulating surface prevents electrons or negative ions from becoming trapped between the exposed conductive surface and the non exposed conductive core." As mentioned above, the arrangement taught in the primary reference *Imafuku* will trap ions between the two ground electrodes because it has opposing exposed surfaces (see Fig. 7 and the description on pages 21-22 of the present invention, which are reproduced above). Based on this, one may say that *Imafuku* teaches away from the claimed invention. Furthermore, *Aruga* does not teach or suggest confining elements. Moreover, it should be emphasized that neither references teaches trapped ions as a problem, and therefore neither reference would propose insulating the conductive core to prevent it. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 29

Also in contrast to the cited references, claim 29 specifically requires, "...wherein the exposed conductive surface that is grounded and the exposed insulating surface that covers a non-exposed conductive core that is electrically grounded cooperate to form a DC potential therebetween when an RF voltage is supplied to the process chamber, the DC potential guiding charged particles to the exposed conductive surface that is grounded, the exposed conductive surface that is grounded sinking the guided charged particles therethrough to ground so as to reduce the density of charged particles in regions outside of the process region." Again neither reference teaches an arrangement, which performs these functions. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 12

Also in contrast to the cited art, claim 12 specifically requires, "wherein the non-exposed conductive core is formed from aluminum and wherein the insulating surface is formed from anodized aluminum." In this particular rejection, the Examiner relied on two other pieces of art: *Takaki* (U.S. Pat. No.: 6,279,504) and *Nawata* (U.S. Pat. No.: 6,444,087). Like *Aruga*, *Takaki* and *Nawata* appear to be completely silent to confining elements, and only mention using these materials to prevent damage and wear. This however, provides no incentive to go in the direction of the claimed invention for the reasons mentioned above. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Independent Claim 23 (and claims 15, 18 and 22)

In the office actions, the Examiner acknowledged some differences between the present invention and the combination of *Imafuku* and *Aruga*. In order to maintain a rejection therefore, the Examiner sought *Hasegawa* to cure the deficiencies thereof. *Hasegawa*, however, does not cure the deficiencies of the *Imafuku* and *Aruga*. In contrast to all three references, claim 23 specifically requires, "...the second confining element including an insulating portion that is exposed within the process chamber, and a conductive portion that is covered by the insulating portion so as to keep the conductive portion from being exposed inside the process chamber, the conductive member being electrically grounded..." *Aruga* is silent to confining

elements and *Imafuku* does not teach an insulating portion that keeps the ground electrodes from being exposed inside the process chamber as mentioned above. Similarly to *Imafuku*, *Hasegawa* does not teach an insulating portion that keeps the conductive ring from being exposed. The most that can be said about *Hasegawa* is that he teaches a conductive ring 22 that attracts electrons floating in the plasma generation region (See Col. 6, lines 32-35). The conductive ring 22, however, is not insulated and therefore the conductive ring is exposed inside the process chamber (which is opposite the teaching of this claim). Not only is the conductive ring exposed, but it also is in electrical contact with the susceptor 12 and the susceptor is connected to RF power supply 44. See for example Col. 5, lines 31-34 and Col. 6, lines 27-32, and Fig. 3 which is reproduced below. This clearly goes in a different direction the claimed invention. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Also in contrast to the cited references, claim 23 specifically requires, "...wherein the first confining element is formed as a first ring configured to surround a first electrode, and wherein the second confining element is formed as a second ring configured to surround a second electrode that is spaced apart and parallel to the first electrode..." As mentioned by the Examiner in the last Office Action (page 8), *Imafuku* and *Aruga* fail to disclose wherein the second confining element is a ring that surrounds a lower electrode. Based on this, the Examiner relied on the member 16 and portion 32 of *Hasegawa*, which surround the susceptor 12 (see Fig. 3 reproduced above). Member 16 and portion 32, however, are not confining elements as required by the claims, i.e., portion 32 is exposed inside the process chamber. None of these references show a ring like non exposed conductor that surrounds the RF electrode, and that is electrically grounded. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Although the rejections to the dependent claims 16, 17, 19-21, 24 and 26 should be withdrawn for at least the same reasons as given above, it should be noted that they offer additional language that is unsupported by the art.

Claim 16

In contrast to the cited references, claim 16 specifically requires, "...wherein the exposed insulating surface is configured to be level with a top surface of the second electrode..." None of the references teach or suggest such a feature. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 17

In contrast to the cited references, claim 17 specifically requires, "...wherein the first ring is configured to be disposed between the first electrode and a chamber wall of the process chamber, and wherein the second ring is configured to be disposed between the second electrode and the chamber wall of the process chamber." None of the references teach or suggest such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 19

In contrast to the cited references, claim 19 specifically requires, "...wherein the second ring includes an inner ring and an outer ring, wherein the inner ring is formed from a dielectric medium and is configured to be disposed between the second electrode and the outer ring, and wherein the outer ring includes the conductive portion and the insulating portion." None of the references teach or suggest such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 20

Also in contrast to the cited references, claim 20 specifically requires, "wherein the conductive element is a portion of the process chamber." *Imafuku* only teaches ground electrodes, which are separate from the process chamber, and *Aruga* is completely silent to confining elements. *Hasegawa* does not overcome these deficiencies. Like *Imafuku* and *Aruga, Hasegawa* does not teach a confining element having an insulated conductive core or a confining element that is a portion of the process chamber. The most that can be said about *Hasegawa* is that he teaches a conductive ring 22 that attracts electrons floating in the plasma generation region

(See Col. 6, lines 32-35). The conductive ring 22 however is not a portion of the process chamber. As shown in Fig. 3 of *Hasegawa*, the conductive ring 22 is mounted on the upper surface of the support pedestal. It should also be noted that the conductive ring of *Hasegawa* electrically contacts the susceptor 12 and thus it is not insulated. Moreover, this goes against the teachings of the present invention, which provides insulation between the conductive portions and the RF electrodes. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 21

Also in contrast to the cited references, claim 20 specifically requires, "...wherein the first ring and the second ring are configured to extend in a radial direction relative to an axis of the process chamber, and wherein an outer edge of the first ring extends further than an outer edge of the second ring." None of the references teach or suggest such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 24

Also in contrast to the cited references, claim 24 specifically requires, "...wherein the first and second confining elements are configured to be located between the process region and an exhaust port." None of the references teach or suggest such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 26

Also in contrast to the cited references, claim 26 specifically requires, "...wherein the exposed conductive member of the first confining element and the exposed insulating portion of the second confining element each include surfaces that are substantially parallel to one another and that are perpendicular to the boundary between the process region where a plasma is ignited and sustained for processing a work piece and the regions outside of the process region where the plasma is not

desired." None of the references teach or suggest such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Independent Claim 8

Also in contrast to the cited references, claim 8 specifically requires, "...a second confining element positioned proximate the periphery of the process region, and including an exposed insulating surface, which is configured to cover a non-exposed conductive core that is electrically grounded." *Imafuku* only teaches a ground electrode in combination with an insulator or another ground electrode. *Imafuku* does not teach insulating one of the ground electrodes as required by the claims. Furthermore, *Aruga* is completely silent to confining elements altogether. The most that can be said is that *Aruga* teaches covering an RF electrode with an insulator. RF electrodes, however, are not plasma grounded confining elements, but rather plasma inducing elements (RF electrodes) that are coupled to an RF voltage source. Moreover, *Hasegawa* teaches a conductive ring. The conductive ring, however is not insulated and further is not grounded (the conductive ring 22 electrically contacts the susceptor 12). Accordingly, the rejection is unsupported by the art and should be withdrawn.

Also in contrast to the cited references, claim 8 specifically requires, "...wherein the first confining element is disposed in an upper portion of the process chamber, and the second confining element is disposed in a lower portion of the process chamber..." None of the references teach or suggest such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Also in contrast to the cited references, claim 8 specifically requires, "...wherein the first confining element is a ring that surrounds an upper electrode, and the second confining element is a ring that surrounds a bottom electrode, the upper and bottom electrode being arranged for producing an electric field that helps to ignite and sustain a plasma." As mentioned by the Examiner in the last Office Action (page 8), *Imafuku* and *Aruga* fail to disclose wherein the second confining element is a ring that surrounds a lower electrode. Based on this, the Examiner relied on the member 16 and portion 32 of *Hasegawa*, which surround the susceptor 12 (see Fig. 3

reproduced above). Member 16 and portion 32, however, are not confining elements as required by the claims, i.e., portion 32 is exposed inside the process chamber. None of these references show a ring like non exposed conductor that surrounds the RF electrode, and that is electrically grounded. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Independent Claim 10

Similarly to claim 8, claim 10 specifically requires, "...a second confining element positioned proximate the periphery of the process region, and including an exposed insulating surface, which is configured to cover a non-exposed conductive core that is electrically grounded..." None of the references teach or suggest such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Also in contrast to the cited references, claim 10 specifically requires, "...wherein the first confining element is disposed in a lower portion of the process chamber, and the second confining element is disposed in an upper portion of the process chamber." None of the references teach or suggest such a limitation. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Also in contrast to the cited references, claim 10 specifically requires, "...wherein the first confining element is a ring that surrounds a bottom electrode, and the second confining element is a ring that surrounds an upper electrode, the upper and bottom electrode being arranged for producing an electric field that helps to ignite and sustain a plasma." None of the references teach or suggest such an insulated conductive core that surrounds an upper electrode. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Independent Claim 30

Similarly to claims 8 and 10, claim 30 specifically requires, "...the exposed insulating surface covering a non-exposed conductive core that is electrically grounded..." As mentioned above, neither reference teaches or suggests such an

arrangement and therefore the rejection is unsupported by the art and should be withdrawn.

Also in contrast to *Imafuku* and *Aruga*, claim 30 specifically requires, "...the exposed conductive surface that is electrically grounded also being configured to attract electric fields so as to reduce the electric field strength in regions outside of the process region...the non exposed conductive core that is electrically grounded being configured to attract electric fields so as to reduce the electric field strength in regions outside of the process region." Both references are completely silent to confining elements that attract electric fields. The most that can be said is that *Imafuku* teaches ground electrodes that attract ions. This however is does not read on the recited claim limitation and thus the rejection is unsupported by the art and should be withdrawn.

<u>Independent Claim 31</u>

Also in contrast to *Imafuku* and *Aruga*, claim 31 specifically requires, "...the lower ring being configured to sink RF electric fields therethrough while preventing the passage of charged particles therethrough..." *Aruga* is silent to confining assemblies and *Imafuku* does not teach or suggest preventing the passage of charged particles through the ground electrode. In fact, *Imafuku* clearly teaches against such an approach. *Imafuka* states repeatedly that the ground electrode attract ions. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Conclusion

The Appellant believes that all pending claims are allowable and respectfully requests that the Board reverse the Examiner's rejections and remand the application to the Examiner with directions to allow the pending claims.

Respectfully Submitted,
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(9) APPENDIX

APPENDIX
PENDING CLAIMS

1. A plasma confining assembly for minimizing unwanted plasma formations in regions outside of a process region in a process chamber, comprising:

a first confining element positioned proximate the periphery of the process region, and including an exposed conductive surface that is electrically grounded; and

a second confining element positioned proximate the periphery of the process region, and including an exposed insulating surface, which is configured to at least partially cover a non-exposed conductive core that is electrically grounded, the second confining element being spaced apart from the first confining element such that one of the confining elements is disposed in an upper portion of the process chamber and the other confining element is disposed in a lower portion of the process chamber,

wherein the first confining element and the second confining element substantially reduces the effects of plasma forming components that pass therebetween.

2. The plasma confining assembly as recited in claim 1 further including a third confining element formed from an insulating material and disposed between the first confining element and the second confining element, and proximate the periphery of the process region, the third confinement element being arranged to physically contain a plasma inside the process region and to substantially reduce the effects of plasma forming components that pass between the first confining element and the second confining element.

3. The plasma confining assembly as recited in claim 2 wherein the third confining element is a ring that surrounds at least a portion of the process region, the third confining element being configured to permit by-product gas from the processing to pass through while substantially confining the plasma inside the process region.

4. The plasma confining assembly as recited in claim 1 wherein the plasma forming components are charged particles or electric fields.

5. The plasma confining assembly as recited in claim 4 wherein the first confining element and the second confining element are arranged to direct charged particles to the exposed conductive surface and sink charged particles therethrough to ground so as to reduce the density of charged particles in regions outside of the process region.

6. The plasma confining assembly as recited in claim 4 wherein the first confining element and the second confining element are arranged to attract electric fields to the grounded conductive surface and the grounded conductive portion, respectively, so as to reduce the electrical field strength in regions outside of the process region.

7. The plasma confining assembly as recited in claim 1 wherein the first confining element is disposed in an upper portion of the process chamber, and wherein the second confining element is disposed in a lower portion of the process chamber.

8. A plasma confining assembly for minimizing unwanted plasma formations in regions outside of a process region in a process chamber, comprising:

a first confining element positioned proximate the periphery of the process region, and including an exposed conductive surface that is electrically grounded; and

a second confining element positioned proximate the periphery of the process region, and including an exposed insulating surface, which is configured to cover a non-exposed conductive core that is electrically grounded, the second confining element being spaced apart from the first confining element such that one of the confining elements is disposed in an upper portion of the process chamber and the other confining element is disposed in a lower portion of the process chamber,

wherein the first confining element and the second confining element substantially reduces the effects of plasma forming components that pass therebetween,

wherein the first confining element is disposed in an upper portion of the process chamber, and the second confining element is disposed in a lower portion of the process chamber, and

wherein the first confining element is a ring that surrounds an upper electrode, and the second confining element is a ring that surrounds a bottom electrode, the upper and bottom electrode being arranged for producing an electric field that helps to ignite and sustain a plasma.

9. The plasma confining assembly as recited in claim 1 wherein the first confining element is disposed in a lower portion of the process chamber, and wherein the second confining element is disposed in an upper portion of the process chamber.

10. A plasma confining assembly for minimizing unwanted plasma formations in regions outside of a process region in a process chamber, comprising:

a first confining element positioned proximate the periphery of the process region, and including an exposed conductive surface that is electrically grounded; and

a second confining element positioned proximate the periphery of the process region, and including an exposed insulating surface, which is configured to cover a non-exposed conductive core that is electrically grounded, the second confining element being spaced apart from the first confining element such that one of the confining elements is disposed in an upper portion of the process chamber and the other confining element is disposed in a lower portion of the process chamber,

wherein the first confining element and the second confining element substantially reduces the effects of plasma forming components that pass therebetween,

wherein the first confining element is disposed in a lower portion of the process chamber, and the second confining element is disposed in an upper portion of the process chamber, and

wherein the first confining element is a ring that surrounds a bottom electrode, and the second confining element is a ring that surrounds an upper electrode, the upper and bottom electrode being arranged for producing an electric field that helps to ignite and sustain a plasma.

11. (canceled)

12. The plasma confining assembly as recited in claim 1 wherein the non-exposed conductive core is formed from aluminum and wherein the exposed insulating surface is formed from anodized aluminum.

13. The plasma confining assembly as recited in claim 1 wherein the conductive surface of the first confining element is formed from an electrically conducting material that is either substantially resistant to etching by a plasma present within the chamber during the processing or contributes substantially no metal contamination.

14. (canceled)

15. The plasma confining assembly as recited in claim 23 further including a pressure control ring formed from a dielectric medium and disposed between the first and second rings, the pressure control ring being configured for physically confining a plasma within the process region, while permitting the passage of process gases to pass therethrough.

16. The plasma confining assembly as recited in claim 23 wherein the exposed insulating surface is configured to be level with a top surface of the second electrode.

17. The plasma confining assembly as recited in claim 23 wherein the first ring is configured to be disposed between the first electrode and a chamber wall of the process chamber, and wherein the second ring is configured to be disposed between the second electrode and the chamber wall of the process chamber.

18. The plasma confining assembly as recited in claim 23 wherein the first ring includes an inner ring and an outer ring, wherein the inner ring is formed from a dielectric medium and is configured to be disposed between the first electrode and the outer ring, and wherein the outer ring includes the conductive member of the first ring.

19. The plasma confining assembly as recited in claim 23 wherein the second ring includes an inner ring and an outer ring, wherein the inner ring is formed from a dielectric medium and is configured to be disposed between the second electrode and the outer ring, and wherein the outer ring includes the conductive portion and the insulating portion.

20. The plasma confining assembly as recited in claim 23 wherein the conductive element is a portion of the process chamber.

21. The plasma confining assembly as recited in claim 23 wherein the first ring and the second ring are configured to extend in a radial direction relative to an axis of the process chamber, and wherein an outer edge of the first ring extends further than an outer edge of the second ring.

22. The plasma confining assembly as recited in claim 17 wherein the first ring is spaced apart laterally from the chamber wall thus leaving an open area between the first ring and the chamber wall.

23. A plasma confining assembly for minimizing unwanted plasma formations in regions outside of a process region in a process chamber, comprising:

a first confining element positioned at a boundary between the process region where a plasma is ignited and sustained for processing a work piece and the regions outside of the process region where the plasma is not desired, the first confining element including a conductive member that is exposed within the process chamber, the conductive member being electrically grounded; and

a second confining element positioned at the boundary between the process region where the plasma is ignited and sustained for processing and the regions outside of the process region where the plasma is not desired, the second confining element including an insulating portion that is exposed within the process chamber, and a conductive portion that is covered by the insulating portion so as to keep the

conductive portion from being exposed inside the process chamber, the conductive member being electrically grounded,

the second confining element being spaced apart from the first confining element so as to form an open area therebetween that permits by-product gases to pass therethrough from the process region to the regions outside of the process region while substantially preventing charged particles or electric fields from passing therethrough from the process region to the regions outside of the process region,

wherein the first confining element is formed as a first ring configured to surround a first electrode, and wherein the second confining element is formed as a second ring configured to surround a second electrode that is spaced apart and parallel to the first electrode, the first and second electrodes defining the process region therebetween, the first and second electrodes being configured for generating an electric field that is sufficiently strong to both ignite and sustain the plasma in the process region of the process chamber.

24. The plasma confining assembly as recited in claim 23 wherein the first and second confining elements are configured to be located between the process region and an exhaust port.

25. (canceled)

26. The plasma confining assembly as recited in claim 23 wherein the exposed conductive member of the first confining element and the exposed insulating portion of the second confining element each include surfaces that are substantially parallel to one another and that are perpendicular to the boundary between the process region where a plasma is ignited and sustained for processing a work piece and the regions outside of the process region where the plasma is not desired.

27. The plasma confining assembly as recited in claim 1 wherein the exposed conductive surface faces the exposed insulating surface such that the exposed insulating surface is disposed between the exposed conductive surface and the non exposed conductive core.

28. The plasma confining assembly as recited in claim 1 wherein the insulating surface prevents electrons or negative ions from becoming trapped between the exposed conductive surface and the non exposed conductive core.

29. The plasma confining assembly as recited in claim 1 wherein the exposed conductive surface that is grounded and the exposed insulating surface that covers a non-exposed conductive core that is electrically grounded cooperate to form a DC potential therebetween when an RF voltage is supplied to the process chamber, the DC potential guiding charged particles to the exposed conductive surface that is grounded, the exposed conductive surface that is grounded sinking the guided charged particles therethrough to ground so as to reduce the density of charged particles in regions outside of the process region.

30. A plasma confining assembly for minimizing unwanted plasma formations in regions outside of a process region in a process chamber, comprising:

a first confining element including an exposed conductive surface that is electrically grounded, the exposed conductive surface that is electrically grounded being configured to sink charged particles therethrough to ground so as to reduce the density of charged particles in regions outside of the process region, the exposed conductive surface that is electrically grounded also being configured to attract electric fields so as to reduce the electrical field strength in regions outside of the process region; and

a second confining element including an exposed insulating surface, the exposed insulating surface covering a non-exposed conductive core that is electrically grounded, the insulating surface preventing charged particles from sinking into the non-exposed conductive core that is electrically grounded, the non-exposed conductive core that is electrically grounded being configured to attract electric fields so as to reduce the electrical field strength in regions outside of the process region.

31. A plasma confining assembly for minimizing unwanted plasma formations in regions outside of a process region in a process chamber, comprising:

an upper ring surrounding an upper portion of the process region, the upper ring being configured to sink charged particles and RF electric fields therethrough; and

a lower ring surrounding a lower portion of the process region, the lower ring being configured to sink RF electric fields therethrough while preventing the passage of charged particles therethrough.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Chen et al. | Attorney Docket No.: KLA1P151

Application No.: 09/676,269 | Examiner: Alejandro Mulero, Luz L.

Filed: September 28, 2000 | Group: 1763

Title: CHAMBER CONFIGURATION FOR CONFINING A PLASMA

CERTIFICATE OF MAILING
I hereby certify that this correspondence is being deposited with the U.S. Postal Service with sufficient postage as first-class mail on May 3, 2004 in an envelope addressed to the Commissioner for Patents, Mail Stop Appeal Brief-Patents, P.O. Box 1450 Alexandria, VA 22313-1450.

Signed: Agnes Spence
Agnes Spence

APPEAL BRIEF TRANSMITTAL
(37 CFR 192)

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Sir:

This brief is in furtherance of the Notice of Appeal filed in this case on February 5, 2004. This brief is transmitted in triplicate.

This application is on behalf of

☐ Small Entity ☒ Large Entity

Pursuant to 37 CFR 1.17(f), the fee for filing the Appeal Brief is:
☐ $165.00 (Small Entity) ☒ $330.00 (Large Entity)

☒ Applicant(s) hereby petition for a <u>one</u> extension(s) of time to under 37 CFR 1.136.

If an additional extension of time is required, please consider this a petition therefor.

☐ An extension for months has already been secured and the fee paid therefor of $ is deducted from the total fee due for the total months of extension now requested.

☒ Applicant(s) believe that no (additional) Extension of Time is required; however, if it is determined that such an extension is required, Applicant(s) hereby petition that such an

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02 FC:1251 110.00 OP

extension be granted and authorize the Commissioner to charge the required fees for an Extension of Time under 37 CFR 1.136 to Deposit Account No. 500388.

Total Fee Due:	
Appeal Brief fee	$330.00
Extension Fee (if any)	$110.00
Total Fee Due	$440.00

☒ Enclosed is Check No. 22364 in the amount of $440.00.

☒ Charge any additional fees or credit any overpayment to Deposit Account No. 500388, (Order No. LAM1P151). Two copies of this transmittal are enclosed.

Respectfully submitted,
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